
NASA-16701 (March 2003)
NATIONAL AERONAUTICS NASA - KSC
AND SPACE ADMINISTRATION SUPERSEDING NASA-16701
(April 2001)

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DIVISION 16 - ELECTRICAL

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NASA-16701 (March 2003)
NASA - KSC
SUPERSEDING NASA-16701
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SECTION 16701

COMMUNICATION/EQUIPMENT ROOMS AND ENTRANCE FACILITIES 03/03

NOTE: Delete, revise, or add to the text in this
section to cover project requirements. Notes are
for designer information and will not appear in the
final project specification.

This section covers requirements for
Communication/Equipment Room and Entrance Facilities.
Accordingly, this section should be tailored
carefully to suit project conditions and to meet
project requirements.

PART 1 GENERAL

1.1 REFERENCES

NOTE: The following references should not be
manually edited except to add new references.
References not used in the text will automatically
be deleted from this section of the project
specification.

The publications listed below form a part of this section to the extent
referenced:

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/TIA/EIA-568-A	(1995) Commercial Building Telecommunications Cabling Standard
EIA ANSI/TIA/EIA-606	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA ANSI/TIA/EIA-607	(1994) Commercial Building Grounding and Bonding Requirements for Telecommunications

UNDERWRITERS LABORATORIES (UL)

UL 497 (1995) Standard for Safety for Protectors
for Paired Conductor Communication Circuits

1.2 GENERAL REQUIREMENTS

NOTE: Review submittal description (SD) definitions
in Section 01300, "Submittals," and edit the
following list to reflect only the submittals
required for the project. Submittals should be kept
to the minimum required for adequate quality
control. Include a columnar list of appropriate
products and tests beneath each submittal
description.

1.2.1 Scope

This section includes the minimum requirements for entrance equipment,
termination hardware, and cable installations in main communication
equipment rooms and communication rooms/closets.

Said spaces shall be equipped to contain the following:

Entrance Facility (EF) Terminals
Surge Protection Modules
Wall Mounted Distribution Frames
Ladder Racking/Cable Tray
Grounding and Bonding Provisions
Backboards
Frame Mounted Termination Blocks and Rings
Cross Connects

1.2.2 Quality Assurance

All spaces shall be built-out in a neat and workmanlike manner.

Equipment and materials shall be of the quality indicated.

Separation from sources of EMI shall be as specified.

Communication grounding/earthing and bonding shall be in accordance with
applicable Codes and regulations. Grounding shall meet the requirements of
EIA ANSI/TIA/EIA-607, and be observed throughout the entire cabling system.

1.2.3 Environmental Requirements

Connecting hardware shall be rated for operation under ambient conditions of 0 to 60 degrees C and in the range of 0 to 95 percent relative humidity, non condensing.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

- Floor Plans
- Front Elevations

SD-03 Product Data

Manufacturer's catalog data shall be provided for the following items:

- Entrance Facility Terminals
- Surge Protection Modules
- Distribution Frames
- Floor Mounted Equipment Racks
- Floor Mounted Equipment Racks and Cabinets
- Wall Mounted Equipment Cabinets
- Wall Mounted Equipment Racks
- Cable Management Hardware
- Patch Panels
- Fiber Optic Panels
- Grounding Bars
- 110 System Blocks
- Patch Cords
- UTP Cross Connects
- Backboards
- Cable Tray

SD-11 Closeout Submittals

- floor plans
- Front elevations
- CAD Generated
- hard copies

1.3.1 Preliminary Drawings

Prior to the start of work, submit preliminary drawings of the following:
(The Contractor shall obtain electronic files of the building floor plans from the Contracting Officer)

Scaled (1/4" - 1'-0") 1:50 Communication Room floor plans showing the

planned location of all installed components.

Front elevations of a typical patch panel for each system.

1.3.2 As-Built Drawings

At the completion of the project, submit final record "As-Built" drawings of the following:

Scaled (1/4" - 1'-0") 1:50 Communication Room floor plans showing all installed components.

Front elevations of all systems patch panels.

Drawings shall be CAD generated on size "F" sheets. Submit reproducible hard copies and electronic copies in ".DXF" or ".DWG" format.

PART 2 PRODUCTS

2.1 ENTRANCE FACILITIES

2.1.1 Entrance Facility Terminals

Entrance facility terminal shall protect all lines (pairs), and input stub (tip) cable shall be [26][Sized by NASA] AWG shielded cable. Contractor shall field verify actual stub length in field. Input stub shall serve as internal fuse link and shall be equipped with a heavy-duty strain relief and encapsulated cable connector. Output stub cable shall be 24 AWG shielded cable. Contractor shall field verify actual stub length in field.

Entrance facility terminals shall be wall or frame mountable, accommodate industry standard 5 pin protection modules (R399A form factor), and the plastic components shall meet or exceed requirements of UL 497.

2.1.2 Surge Protection Modules

Surge protection modules shall be 5 pin, 3 element gas type protection modules and shall provide true balanced operation. Over voltage on either side shall cause the entire tube to ionize to provide a simultaneous path to ground for both sides of the circuit. Surge protection modules shall be UL 497 listed. Ground pin shall be tin, tip and ring pins shall be gold alloy, and the module color shall be black. Surge protection modules color shall be green for spare pair modules. The nominal DC breakdown shall be 350V @ 100V/usec. The impulse breakdown voltage shall be 700A @ 100V/usec and 150A @1KV/usec.

The surge protection modules DC holding current shall be 135V for <150ms. The surge protection modules surge life (min. operations) shall be as follows:

@10A, 10 x 1000usec

The capacitance shall be <1pf for 1 Vrms @ 1Khz, 50 DCV. The insulation resistance shall be >100M ohms @ 50 VDC. The fail safe operation shall be as follows:

@1.0A	<50 sec
@5.0A	<15 sec
@20A	<10 sec
@60A	<3 sec

The current limiters shall be as follows:

hold current (ma) @ 20 C = 145
R min / max ohms = 3/6

2.1.3 Floor Mounted Frames for Protection Terminals

Provide 84"2.1m high frames suitable for single side mounting of protection terminals, the overall width of frame shall be 35.5"0.9m and depth shall be 15"381mm, and the frame shall be supplied with 12"305mm cable runway support, junctioning bolts, aluminum bond bars, grounding screws and screws for installing the blocks. Floor mounted frames for protection terminals shall have 6"153mm vertical channel to feed cables to blocks and the lowest installed block shall be 6"153mm A.F.F.

2.1.4 Floor Mounted Distribution Frames

Provide 84"2.1m high frames suitable for single side mounting of 110 termination blocks. The frame shall be configured to support the number of pairs indicated on the drawings, the overall width of frame shall be 37.5"953mm and depth shall be 16.13"409mm. Frame shall be supplied with 12"305mm cable runway support, junctioning bolts, bond bars, grounding screws and screws for installing the blocks. The frame shall be divided into two modules. The top module shall support six (6) 110 blocks and the bottom module shall support nine (9) 110 blocks, with the lowest installed block being 18"457mm A.F.F. Rack shall have 6"153mm vertical channel to feed cables to blocks.

2.1.5 Steel Ladder Racking/Cable Tray

Provide ladder rack/cable tray in equipment room, as shown on drawings for backbone cable support. Include connecting and support hardware to suit installation, including but not limited to, racks, runway mount plates, wall angle support brackets, butt splice swivels, connect junctions and grounding kit.

2.1.6 Grounding and Bonding

Provide grounding bar assembly as shown on drawings, and a minimum #2 grounding electrode conductor from ground bar to suitable electrical building ground. Label grounding and bonding hardware and connections per EIA ANSI/TIA/EIA-606. Grounding wire shall be appropriately bonded to the grounding bar and electrical building ground. Ground bar assembly to be constructed with following materials (See drawing details for additional information):

- a. Copper ground bar (1/4" x 4" x 12")6mm x 102mm x 305mm with 9/32" 7mm holes spaced 1-1/8"32mm apart.

- b. Stand-off insulators.
- c. Lockwashers.
- d. Wall mounting brackets.

2.1.7 Backboards

Backboards shall be 4' x 8' x 3/4" 1.2m x 2.4m x 19mm ACX or CX, fire rated plywood, or as indicated on the drawings. Backboards shall be painted gray, acrylic, interior, fire, retardant paint.

Contractor shall install open end distribution rings for wall mounted cross-connect fields above all wall mounted blocks. Two ring per vertical row.

2.1.8 Termination Blocks on Frame

Blocks shall be 110 style 300 pair blocks. Provide connecting clip, designation strip, plastic covers and retaining clip necessary to terminate cables.

2.1.9 UTP Cross Connects

Cross connect wire shall be of same gauge (22 AWG and 24 AWG) as the feed cable to which it is being connected to. Typically, cross connect wire will be 24 AWG single twisted pair and dual twisted pair wire as required for circuit being connected. Conductors shall be rated a minimum of Category 5E. Cross connect wire colors shall be:

- a. White-Blue for voice circuits.
- b. White-Red for fire alarm.
- c. White-Black for temporary circuits.
- d. Solid colored White-Blue-Red-Green for 4 wire services.

2.2 COMMUNICATIONS/EQUIPMENT ROOMS

2.2.1 Floor Mounted Equipment Racks

Racks shall meet the following physical specifications:

- a. 19" 483 mm rack mounting space.
- b. 7'-0" 2.1 m tall.
- c. Lightweight, high strength aluminum construction.
- d. Black powder coat finish.
- e. 15" 381 mm deep base with four (4) 3/4" 19 mm bolt down holes.

- f. EIA Channel width of 3.0"76 mm, with #12-24 screw holes.

Rack shall have double sided 12/24 tapped holes and EIA universal rack 5/8" to 5/8"-1/2")16 mm to 16 mm - 13 mm standard hole pattern (compatible with 11/4" - 1/2"32 mm - 13 mm hole patterns).

2.2.2 Wall Mounted Equipment Racks

Wall mounted equipment racks shall meet the following physical specifications:

- a. 19"483 mm rack mounting space.
- b. 48"1.2 m high with 24 mounting spaces.
- c. Lightweight, high strength steel construction.
- d. Black powder coat finish.
- e. Stationary mounting with 21"533 mm deep, 14 gauge mounting brackets and 100 lb.45 kg capacity.
- f. Racks shall have double sides EIA universal rack 5/8" to 5/8"-1/2" 16 mm to 16 mm-13 mm standard hole pattern, (compatible with 11/4" - 1/2"32 mm - 13 mm hole patterns).

2.2.3 Wall Mounted Equipment Cabinets

Wall mounted equipment cabinets shall meet the following specifications:

- a. 19"483 mm equipment mounting space.
- b. 48"1.2 m high with 26 rack mount spaces.
- c. Universal mounting rails with 10/32 and 12/24 tapped holes.
- d. 5/8" to 5/8"-1/2"16 mm to 16 mm-13 mm EIA standard hole pattern.
- e. Black powder coat finish.

Cabinets shall have a two hinge design for front and rear access, louvered sides for ventilation, knockouts in top and bottom for cable access. Both front and rear access shall be lockable.

2.2.4 Floor Mounted Cabinet

Floor mounted cabinets shall meet the following specifications:

- a. 16 gauge steel construction.
- b. Nominal 77" x 19" x 30"1956 mm x 483 mm x 762 mm.
- c. Lockable plexiglass hinged door on front and steel hinged door in

rear.

d. Vented roof.

e. Removable side panels.

f. Leveling feet.

2.2.2.5 Cable Management for Equipment Racks

Cable management shall be black metal with integral wire retaining fingers.

Vertical cable management panels shall have front and rear channels.

Vertical cable management panels shall have removable front and back covers, made of black metal. A horizontal crossover cable manager shall be provided at the top of each relay rack, with a minimum height of 2 rack units each. A horizontal crossover cable manager shall be provided near the center and at the bottom of each relay rack, with a minimum height of 4 rack units.

2.2.2.6 Patch Panels - Category 5E

The termination panels shall support the appropriate Category 5E applications and facilitate cross-connection and inter-connection using modular patch cords. Patch panels shall be sized to fit an EIA standard 19 inch 483 mm rack, or be capable of mounting to a wall. Patch panels shall accommodate at least 48 ports for each rack mount space, and have circuit boards tested in both directions as required by EIA ANSI/TIA/EIA-568-A. Patch panels shall have angle left/angle right modules to provide optimum cable management, and shall have removable six port modules to allow replacement in the field. Patch panels shall have Category 5E jacks available in both T568A and T568B wiring schemes, with 110-style termination.

Patch panels shall allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit, and have modular ports compliant with FCC CFR 47, part 68, subpart F and IEC 60603-7 with gold plating over nickel contacts or equivalent. They shall allow the use of a 4-pair 110-style impact termination tool. Patch panels shall have a plastic strip for physical protection of printed circuit board, have port identification numbers on both the front and rear of the panel, and provide clear label holders and white designation labels with the panel, with optional color labels available. Patch panels shall be EIA ANSI/TIA/EIA-568-A proposed Category 5E compliant.

The following performance requirements shall be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

PARAMETERS	PERFORMANCE @ 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB

PARAMETERS
Return Loss

PERFORMANCE @ 100 MHz
20 dB

Shall be UL verified for TIA/EIA Category 5E electrical performance, shall be made of a steel frame with black powder coat finish, 48 and 96 port configurations. Shall allow the modular insert to accept 110-style patch plugs as a means of termination, shall be T-568-B wired, provide 48 port panels, unless otherwise noted. Shall be paired punch down sequence to allow pair twist within 1/2"13 mm of the termination. Provide port configurations and densities as called for on drawings, provide rear cable management bar(s) as recommended by the manufacturer, and shall be insulation displacement connector 110-style terminations. Provide EIA ANSI/TIA/EIA-606 compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality as required.

2.2.7 Fiber Optic Panels - Wall Mount Box

All panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers. Wall mount boxes shall be available in 12,24 port termination densities for a single door applications, shall be available in 12, 24 and 48 port termination densities for dual door applications, accommodate various Simplex connectors including ST, SC, FC, LX.5, and MT-RJ, and have single or dual hinged doors. Wall mount boxes shall have the ability to mount the cable clamp on the interior of the panel, feature adapters which are angled, and have radiused outer edges and be putty white in color. Wall mount boxes shall offer factory termination of the optical cable as an option, and provide port configurations and densities as called for on drawings.

2.2.8 Fiber Optic Panels - Rack Mount (Low Fiber Count)

All panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers. Rack mount panels shall be available in 12 and 24 port with no splicing, be available in 24 port configuration for splicing, and allow mounting in either 19 inch483 mm or 23 inch584 mm equipment bays. Rack mount panels shall allow flush or 5 inch127 mm recess mounting, use adapter plates that house a minimum of six (6) adapters each, and have adapters angled to the left and right of the panel. Rack mount panels shall be available in black or putty. They shall meet or exceed all TSB-72 requirements, provide port configurations and densities as called for on drawings, and shall be wall or rack mountable. Rack mount panels shall have a hinged removable front cover and feature a front access design with a hinged bulkhead plate.

2.2.9 Fiber Optic Panels/Frames - Rack Mount (Moderate Fiber Count)

All panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers. They shall be available in 12, 24, 48, 72, and 96 port configurations, feature a front access design with hinged bulkhead plate, and use adapter plates that house six (6) adapters each.

They shall have a hinged removable front cover, adapters that are angled to the left of the panel, have an integrated vertical cableway on one side of the panel, and be mountable in flush, 1", 2", and 5" 25 mm, 50 mm, and 127 mm recess options, and shall be wall mountable. They shall be 19 inch and 483 mm and 23 inch 584 mm rack mountable, have storage and splicing options as part of the product offering, and be available in black or putty.

2.2.10 Fiber Optic Frames - Rack Mount (High Fiber Count)

All panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers. They shall be available in putty or black, and made of 12-gauge aluminum alloy. They shall be available in up to 24, 32, 48, and 72 port versions with ST or MT-RJ fiber adapters pre-loaded into adapter plates, or 48, 64, 96, and 144 port versions using quad SC fiber adapters pre-loaded into adapter plates. They shall have pre-loaded adapter plates with SC, ST, or MT-RJ fiber adapters in 6 and 8 port versions, as well as a 12 port version for the SC adapter and have blank adapter plates for future growth of the fiber infrastructure.

Frames shall have fiber managers to effectively store fiber cable slack and comply with fiber bend radius requirements, have six and eight port fiber adapter plates, which allow for color coding connectors, and accommodate stackable splice trays, each tray manages a minimum total of 24 splices. They shall have an adapter plate-mounting bracket, which slides out to the front and to the rear of the unit for increased access, have capable access points for fiber jumpers entering and exiting the unit, with rotating grommets to facilitate cable loading and to minimize micro bending stress, and have anchor points for fiber cable(s) entering the unit. They shall have labeling which meets or exceeds EIA ANSI/TIA/EIA-606 requirements and also be laser printable.

All frames shall be mountable both 19 inch 483 mm and 23 inch 584 mm rack/cabinets. Provide port configurations and densities as called for on the drawings.

2.2.11 Fiber Optic Trays - Rack Mount

All panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers. The rack mount trays shall be made of 18-gauge steel with a black finish, be available in 16-, 24-, 28-, 32-, and 48-port configurations, and be able to double that port count utilizing 6-port adapters. They shall accommodate SC, ST, and MT-RJ adapters, accommodate hybrid adapter bezels for ST-to-SC or SC-to-ST, or MT-RJ to MT-RJ connections, and have changeable ports, which are removed from the front of the unit to allow custom configuration or modification.

The rack mount trays shall have silk screened port identification numbers provided on both the front and rear of the panel, include fiber managers that manage slack storage so as to comply with fiber bend radius requirements and slack storage length recommendations, accommodate stackable splice trays, which manage up to 24 splices per tray, and have a smoked polycarbonate cover with quarter turn screws for easy access. The

rack mounted trays shall not exceed a 10 in254 mm depth for mounting in standard cabinets and enclosures, shall be provided with strain relief lugs for the fiber cable entering the unit from the side or back, and provide port configurations and densities as called for on drawings.

2.2.12 Backboards

Backboards shall be 4 x 8 x 3/4"1.2 m x 2.4 m x 19 mm ACX, exterior grade, fire rated plywood, and shall be painted - gray, acrylic, interior, fire retardant paint. Backboards shall provide adequate support and dress horizontal cabling between ladder rack and 110 wiring blocks as necessary or as shown on the drawings. Review cable routing plan for the Telecommunications Rooms, in the field, before installation of cabling commences.

2.2.13 110 System Blocks

The connecting hardware block shall support the appropriate Category 3 or Category 5E applications and facilitate cross-connection and/or inter-connection using either approved cross-connect wire or patch cords. System blocks shall be 110 System IDC style blocks, UL verified or equivalent for TIA/EIA Category electrical performance, and EIA ANSI/TIA/EIA-568-A Category 3 or Category 5E compliant.

The following criteria shall be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

PARAMETERS	PERFORMANCE @ 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB
Return Loss	20 dB

The system blocks shall be made of flame retardant thermoplastic, be available in 50-, 100-, and 300-pair sizes, and have 50-, 100-, and 300-pair blocks available without legs, while the 100, and 300 pair blocks are available with legs. Blocks shall include means to identify cables/services per EIA ANSI/TIA/EIA-606, shall have clear label holders with the appropriate colored inserts available for the wiring blocks. The insert labels provided with the product shall contain vertical lines spaces on the basis of circuit size (3-, 4-, or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords. Label holders must be capable of mounting in the under portion of the wiring block. System blocks shall have connecting blocks used for either the termination of cross-connect (jumper) wire or patch cords. The connecting blocks shall be available in 3-, 4-, and 5-pair sizes.

All connecting blocks shall have color-coded tip and ring designation markers and be of single piece construction. System blocks shall have connecting blocks with a minimum of 200 re-termination without signal degradation below standard compliance limit. They shall support wire sizes: Solid 22-26 AWG (0.64 mm - 0.40 mm), and 7-strand wires. They

shall be made by an ISO 9001 Certified Manufacturer and shall be 300 pair blocks, typical for feed and station cable, unless otherwise noted. Provide keep-off indicator buttons on all active cross-connected pairs used for alarm and security purposes. Coordinate the color and use with the Contracting Officer. Provide connecting block designation label strips of the colors conforming to EIA ANSI/TIA/EIA-606.

2.2.14 Cross Connect

Provide modular 110 cross connect blocks for all backbone terminations. Cross connects shall be made with wire of equal gauge and performance category to that of the feed cable, which it is being connected to. Cross connect shall be UL listed, and provide one (1) roll of 1-pair and one (1) roll of 2-pair per Telecommunications Room (TR). Coordinate color code of one and two pair with COTR.

2.2.15 Grounding Bars

Provide grounding bar assembly as shown on drawings and a minimum #4 grounding electrode conductor from ground bar to suitable electrical building ground. Label grounding and bonding hardware and connections per EIA ANSI/TIA/EIA-606. Grounding wire shall be appropriately bonded to the grounding bar and electrical building ground rod. The ground bar assembly shall be constructed with the following materials (see drawing details for additional information):

- a. Copper ground bar (1/4" x 4" x 10") with 9/32" holes spaced 1-1/8" apart.
- b. Stand-off insulators.
- c. Lockwashers.
- d. Wall mounting brackets.

2.2.16 Optical Fiber Patch Cords - Multimode

Optical fiber patch cords shall be available in standard lengths of 1, 3, and 5 meters, custom lengths shall also be available, and shall meet or exceed standards as defined in EIA ANSI/TIA/EIA-568-A. They shall utilize duplex optical fiber cable that is 62.5/125 or 50/125 micron multimode, OFNR riser grade, shall utilize optical fiber cable where the attenuation shall not exceed 3.5 dB/km @ 850 nm wave length or 1.0 dB/km @ 1300 nm, and shall be equipped with SC, ST, or MT-RJ connectors. Patch cords shall have terminated connectors exhibit a maximum insertion loss of 0.75 dB with an average of 0.40 dB when tested at either 850 nm or 1300 nm wave lengths for 62.5/125 um, and have terminated connectors exhibit a maximum insertion loss of 0.75 dB with an average of 0.50 dB when tested at either 850 nm or 1300 nm wave lengths for 50/125 um. Optical fiber patch cords shall have a minimum return loss of 20 dB (25 dB typical) at both 850 nm and 1300 nm. They shall be a duplex fiber cable meeting or exceeding the transmission characteristics of the optical fiber horizontal cable. Provide configuration of patch cords as required to accommodate the application.

2.2.17 Category 5E Patch Cords

Category 5E patch cords shall be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame retardant jacket, and shall be equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring. Use modular plugs and have gold plating over nickel contacts. Category 5E patch cords shall be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants, utilize cable that exhibits power sum NEXT performance, and shall be available in several colors with or without color strain relief boots providing snagless design.

Category 5E patch cords shall meet the flex test requirements of 1000 cycles with boots and 100 cycles without boots, be available in any custom length and standard lengths of meters (3, 5, 7, 10, 15, 20, and 25 feet), and input impedance without averaging shall be 100 ohms +/- 15% from 1 to 100 MHz. Category 5E patch cords shall utilize cable that is UL verified (or equivalent) for TIA/EIA proposed Category 5E electrical performance.

PART 3 EXECUTION

3.1 ENTRANCE FACILITY TERMINALS

Terminals shall be frame mounted. Field verify actual length required for the input and output stubs. If the scope of work does not include splicing of the tip cable to the feed cable, provide clear labeling at the splice end of the tip cable referencing rack, row, and block information. Coordinate with Owner. Terminate output stub to appropriate block on distribution frame. Coordinate with Owner. Install #4 grounding conductor as straight as possible from terminal to ground bar.

3.2 SURGE PROTECTION MODULES

Contractor shall fully protect all pairs entering a building, either with active pair surge protection modules or surge protection modules specified of inactive pairs. Contractor to provide cost allowance in base bid for 80% active modules and 20% shunt modules.

3.3 FLOOR MOUNTED DISTRIBUTION FRAMES

Install frames as per drawings, in accordance with manufacturer instructions. Frames shall be securely fastened to the floor using expansion anchors, and shall be plumb and square with the room.

3.4 STEEL LADDER RACKING/CABLE TRAY

Install all ladder rack/cable tray and associated mounting hardware in a manner that will allow it to support its maximum rated load. Ladder rack/cable tray shall be located a minimum of 457 mm above top of floor mounted rack or wall mounted cross-connect fields. Installation shall comply with manufacturer's instructions.

3.5 TERMINATION BLOCKS ON FRAME

Install color designation strips as follows:

DESCRIPTION	COLOR
C.O. Circuits	Orange
Common Equipment - PBX, Lan's, Muxes	Purple
First Level Backbone Cable	White
Second Level Backbone Cable	Gray
Horizontal Wiring	Blue
Auxiliary Circuits - Alarm, Security	Yellow
Future use and Key Systems	Red
Inter-building Campus Backbone	Brown

Install red insulator clips on all special circuits in the Main Equipment Room termination hardware and cross-connect facilities (ER). Confirm with the COTR which circuits shall be designated as special.

3.6 FLOOR MOUNTED EQUIPMENT RACKS AND CABINETS

All floor mounted equipment racks shall be anchored to the floor and be plumb, provide vertical and horizontal cable and terminations as shown on the drawing, and mount with a minimum of 36 inches1 m clear access behind and front of rack from the wall to a rack. Floor mounted equipment racks shall ground the rack to the equipment ground bar. Adjacent racks can be bonded together. Communication grounding/earthing and bonding shall be in accordance with applicable Codes and regulations. Floor mounted equipment cabinets shall be installed in a location which allows both the front and rear door to open a full 90 degrees. Cabinets employing cooling fans shall be installed such that there is at least 6"152 mm of clear space above the top of the fan casing.

3.7 WALL MOUNTED EQUIPMENT RACKS AND CABINETS

Secure wall mounted equipment racks to building structure with approved anchoring means, verify all existing wall construction and submit proposed anchoring methods for approval, and provide vertical and horizontal cable management both front and rear wherever available. Wall mounted equipment cabinets shall be installed in such a way as to not interfere with the use of the front door or hinged body section.

3.8 CABLE MANAGEMENT

A horizontal crossover cable manager shall be provided at the top and bottom of each rack, with a minimum height of 2 rack units each. A horizontal crossover cable manager shall be provided near the center of each relay rack, with a minimum height of 4 rack units. Provide two rear cable management bars and reusable velcro-type hook and loop straps in each rear vertical channel. Reusable straps shall be of varying sizes (each allowing 50% spare future expansion) and of adequate quantity to secure cable bundles at least every 4 rack units. Secure cable managers, slack managers, support bars, hook and loop straps per manufacturer recommendations.

3.8.1 Cable Supports

Provide "D" rings on 0.6m center for all exposed, wall mounted vertical Category 5E cable runs. All horizontal cable runs within room shall be on cable tray.

3.9 CATEGORY 5E PATCH PANELS

Install and label Category 5E patch panels as recommended by manufacturer, per all EIA ANSI/TIA/EIA-606. Install rear cable management bar(s) as recommended by manufacturer, and Install EIA ANSI/TIA/EIA-606 compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality.

Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches13 mm.

Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket, or other appropriate mounting device.

Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts.

Panels shall be properly labeled on front and back with the cable number and port connections for each port.

3.10 OPTICAL FIBER PATCH PANELS

Panel shall be installed according to manufacturer's instructions. Furnish and install labels for each strand, and install blank adapter panels in all positions not used at time of installation for fiber terminations.

Adhesive or snap-in routing clips shall be secured to the inside of the adapter tray in such a fashion as to allow the maintenance of the minimum bend radius if the cable and the proper storage of at least 2 m of fiber cable inside the tray.

Incoming cable shall be properly anchored as it enters the rear or bottom of the tray. Anchor shall be attached to the cable jacket without excessive force and without crushing the cable jacket.

3.11 BACKBOARDS

Linear wall space used for anchoring equipment shall be lined for the full room width with plywood, per the drawings. Plywood for mounting termination equipment shall be installed vertically, side by side, a minimum of 6 inches152 mm above finished floor. Mounting shall be sufficient enough to support the equipment. Plywood for supporting backbone riser cables shall be installed vertically, resting directly on the finished floor. Anchoring and mounting techniques of plywood used to

support backbone riser cables shall be sufficient to support a minimum of 1000 pounds453 kg of weight. In no cases shall the heads of mounting screws protrude past the face of any plywood. Install distribution rings for the cross-connect fields above all wall mounted blocks. Two rings per vertical row of blocks. Mount rings with two hex head screws per ring.

3.12 110 SYSTEM BLOCKS

110 system blocks shall be installed on plywood backboard so that top of 300 pair block is 5'-6"1.7 m above finished floor, or as noted on the drawing. Mount blocks with steel, zinc plated 5/16 inch8 mm slotted hex head #10 x 3/4 inch19 mm drill screws, minimum four screws per block. Install designation strips color-coded in conformance with EIA ANSI/TIA/EIA-606 standard, generally as follows:

DESCRIPTION	COLOR
C.O. Circuits	Orange
Common Equipment - PBX, :LAN's, Muxes	Purple
First Level Backbone Cable	White
Second Level Backbone Cable	Gray
Horizontal Wiring	Blue
Auxiliary Circuits - Alarms, Security	Yellow
Future Use and Key Systems	Red
Inter-building Campus Backbone	Brown

3.13 GROUNDING AND BONDING

Install a copper ground bar in each communication equipment room, as per the plans, and bond all metallic equipment racks, conduits, cable tray, ladder racks, etc. to the ground bar, using #6 AWG (minimum) equipment grounding conductor. All connectors and clamps shall be mechanical type made of silicon bronze, and terminals shall be solderless compression type, copper long-barrel NEMA two bolt. Bond the shield of shielded cable to the ground bar in communications rooms and spaces, per applicable code and manufacturer's recommended practices. Communication grounding/earthing and bonding shall be in accordance with applicable codes and regulations.

3.14 MISCELLANEOUS REQUIREMENTS

Neatly dress, rack, label, and terminate all cables in communication rooms. Provide a minimum of 24 inches609 mm service loop on each terminated conductor, unless otherwise specified.

Room support services including HVAC, lighting, power, and fire protection shall be as indicated on the drawings.

Firestop all sleeves and conduit openings after the cable installation is complete.

-- End of Section --